Claims

What is claimed is:

1. A method for continuously monitoring airborne particles, the method comprising a plurality of cycles, each cycle comprising:

depositing airborne particles on a collection surface to form a spot,

analyzing the spot, and

regenerating the collection surface.

2. The method according to claim 1 wherein depositing airborne particles is by impaction caused by directing an air stream at the collection surface.

3. The method according to claim 1 wherein analyzing is selected from measuring biological, chemical, and radiological properties.

4. The method according to claim 1 wherein analyzing comprises measuring a plurality of properties.

5. The method according to claim 1 further comprising pre-concentrating airborne particles within a sizes range prior to impacting.

6. The method according to claim 5 wherein the size range is between about 0.5-10 μm.

7. The method according to claim 6 wherein the spot comprises biological particles.

8. The method according to claim 1 wherein regenerating is by rotating a felt wheel over the collection surface.

9. A method for continuously monitoring airborne particles, the method comprising a plurality of cycles, each cycle comprising:

impacting an air stream on a collection surface to form a spot,

analyzing the spot, and

regenerating the collection surface.

10. The method according to claim 9 further comprising moistening the collection surface prior to depositing airborne particles.

11. The method according to claim 10 wherein moistening is with alcohol, glycerol, or medium weight hydrocarbon.

12. The method according to claim 11 wherein moistening is with octane.

13. The method according to claim 9 further comprising preconditioning the air stream by removing particles of sizes greater than about 10 μm.

14. The method according to claim 9 wherein regenerating is by pressing a felt pad against the collection surface and moving the felt pad over the collection surface.

15. The method according to claim 9 wherein regenerating comprises electrostatically charging the collection surface.

16. The method according to claim 9 wherein analyzing the spot comprises measuring at least one of fluorescence, infrared absorption, mass spectra, Raman spectrometer, gamma emission, alpha emission, or beta emission properties of the spot.

17. The method according to claim 9 wherein analyzing comprises pre-treating the spot.

18. The method according to claim 17 wherein pre-treating comprises adding to the spot a liquid comprising an analysis-enhancing compound.

19. The method according to claim 17 wherein analyzing the spot comprises plasma lysing.

20. The method according to claim 17 wherein pre-treating comprises plasma lysing and adding matrix solution, and analyzing is by measuring mass spectra by MALDI mass spectrometry.

21. A method for continuously monitoring airborne particles, the method comprising a plurality of cycles, each cycle comprising:

impacting an air stream on the collection surface to form a spot,

analyzing the spot by measuring fluorescence properties of the spot, and

regenerating the collection surface.

22. The method according to claim 21 wherein at least a subset of the plurality of cycles additionally comprise:

(a) after regenerating, verifying regeneration of the collection surface by analyzing the regenerated collection surface by measuring the fluorescence properties of the regenerated collection surface to obtain a background fluorescence level,

(b) comparing the background fluorescence level to predetermined criteria, and

if necessary, repeating steps (a) and (b) until predetermined criteria are met.

23. The method according to claim 21 wherein regenerating is by brushing the collection surface with a brush.

24. The method according to claim 21 wherein regenerating is by blowing an air jet towards the collection surface.

25. The method according to claim 21 wherein regenerating is by scraping the collection surface with a blade.

26. The method according to claim 21 further comprising pre-concentrating airborne particles within a size range of

about 0.5-10 μm prior to impacting and preconditioning the air stream by removing particles of sizes greater than about 10 μm prior to pre-concentrating.

27. A device comprising:

an impaction plate,

a collection surface on the impaction plate,

a spotting nozzle for directing an air stream towards the collection surface, whereby impact of the air stream on the surface forms a spot of airborne particles on the collection surface,

an analyzer,

a surface regenerator, and

a homing sensor, wherein the homing sensor is capable to cyclically position the collection surface sequentially from the nozzle to the analyzer and to the surface regenerator.

28. The device according to claim 27 wherein the collection surface is smooth.

29. The device according to claim 27 wherein the spot is enriched in particles of 1-10 μm size range.

30. The device according to claim 27 wherein the analyzer is a fluorescence detector.

31. The device according to claim 27 wherein the analyzer is an infrared absorbance detector.

32. The device according to claim 27 wherein the analyzer is a mass spectrometer.

33. The device according to claim 27 wherein the analyzer is a surface enhanced Raman spectrometer.

34. The device according to claim 27 wherein the surface regenerator is a felt wheel.

35. The device according to claim 27 wherein the impaction plate comprises a plurality of collection surfaces.

36. The device according to claim 27 further comprising at least one particle concentrator upstream of the nozzle.

37. The device according to claim 27 further comprising a size selective inlet upstream of the nozzle.

38. The device according to claim 27 wherein the impaction plate is a lobed cam having a shaft, the impaction plate comprises at least one planar collection surface substantially parallel to the shaft, and the homing sensor comprises the shaft.

39. A device comprising:

an impaction plate,

a collection surface on the impaction plate,

a spotting nozzle for directing an air stream towards the collection surface, whereby impact of the air stream on the surface forms a spot of airborne particles on the collection surface,

means for analyzing the spot,

means for regenerating the collection surface, and

means for translocating the collection surface relative to the nozzle, the analyzer, and the surface regenerator.

40. The device according to claim 39 wherein the means of analyzing the spot is selected form the group consisting of means for measuring biological, chemical, and radiological properties.

41. The device according to claim 39 wherein the means of analyzing the spot is a fluorescence detector.

42. The device according to claim 39 wherein the means for regenerating the collection surface comprises a felt pad.

43. The device according to claim 39 wherein the means for translocating the collection surface comprises a shaft attached to the impaction plate, wherein rotation of the shaft at predetermined angles operatively positions the collection surface to the spotting nozzle, the means for analyzing the spot, and the means for regenerating the collection surface.

44. The device according to claim 39 further comprising at least one particle concentrator upstream of the nozzle.

45. The device according to claim 39 further comprising a size selective inlet upstream of the nozzle.

46. The device according to claim 39 wherein the impaction plate is a lobed cam having a shaft, the impaction plate comprises at least one planar collection surface

substantially parallel to the shaft, and the means of translocating comprises the shaft.

47. A device comprising:

an impaction plate,

a collection surface on the impaction plate,

a liquid coating applicator for moistening the collection surface,

a spotting nozzle for directing an air stream towards the collection surface, whereby impact of the air stream on the surface forms a spot of airborne particles on the collection surface,

an analyzer for examining the spot,

a surface regenerator capable of removing the deposit from the collection surface, and

a homing sensor, wherein the homing sensor is capable to operatively position the collection surface to the liquid coating applicator, the nozzle, the analyzer, and the surface regenerator.

48. The device according to claim 47 wherein the liquid coating applicator is a felt tip pen.

49. The device according to claim 47 wherein the liquid coating applicator comprises alcohol, glycerol, or medium weight hydrocarbon.

50. The device according to claim 49 wherein the liquid coating applicator comprises octane.

51. The device according to claim 47 wherein the regenerator is selected from the group consisting of a brush, a blade, a felt pad, and a felt wheel.

52. The device according to claim 51 wherein the regenerator further comprises means of electrostatically charging the collection surface.

53. The device according to claim 47 wherein the impaction plate is a disk having an axis, the homing sensor comprises a shaft positioned along the axis and bound to the disk, and wherein the homing sensor functions by rotating the impaction plate at predefined angles.

54. The device according to claim 47 further comprising at least one particle concentrator upstream of the nozzle.

55. The device according to claim 47 further comprising a size selective inlet upstream of the nozzle.

56. The device according to claim 47 wherein the impaction plate is a lobed cam having a shaft, the impaction plate comprises at least one planar collection surface substantially parallel to the shaft, and the homing sensor comprises the shaft.

57. A device comprising:

an impaction plate,

a collection surface on the impaction plate,

a nozzle for directing an air stream towards the collection surface, whereby impact of the air stream on the surface forms a spot of airborne particles on the collection surface,

a pre-analysis spot preparation station,

an analyzer for examining the spot,

a surface regenerator capable of removing the deposit from the surface after analysis, and

a homing sensor, wherein the homing sensor is capable to operatively position the collection surface to the nozzle, the analyzer, and the surface regenerator.

58. The device according to claim 57 wherein the surface comprises pyramid-shaped structures of about 1-10 μm in height and width.

59. The device according to claim 57 wherein the surface regenerator comprises a regenerator nozzle for blowing air towards the collection surface.

60. The device according to claim 57 wherein the impaction plate is a lobed cam having a shaft, the impaction plate comprises at least one planar collection surface substantially parallel to the shaft, and the homing sensor comprises the shaft.

61. The device according to claim 57 further comprising at least one particle concentrator upstream of the nozzle.

62. The device according to claim 57 further comprising a size selective inlet upstream of the nozzle.

63. The method according to claim 17 wherein pre-treating comprises heatingthe spot for pyrolysis mass spectrometry.